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# An overview of global climate changing in current scenario and mitigation action

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ABSTRACT

Climate changing is a global threat to the world. There are so many reasons behind this problem. One of the major reasons is carbon emissions in atmosphere. The causes for this global threat are many, among them GHG (green house gas emission) is one of them. Also deforestation, land use change, sulfate aerosol and black carbon are the other major reason leading to the ozone layer depletion and changing climate.

Due to the carbon emission atmosphere is being polluted and also so many disasters happen routinely. Atmosphere is getting hot day by day. Due to this unnatural and sudden temperature rise, glaciers are melting, so sudden flash floods occur. Agricultural sector is also suffering due to the global warming effects. This will also affect the productivity of grains world wide. Climate changing increases land and as well as sea temperature and alters precipitation quantity and patterns. As a result increasing the global average sea level, risk of coastal erosions, etc. climate change will be an added stress for the fisheries and aquaculture sectors. Effects will also be severe on coasts and marine ecosystems. Extreme events like drought, flood may also happen due to these impacts. This paper elaborately present the current situation of climate changing and the causes of its vulnerable effects, also the mitigation action of climate changing are also discussed.



**Contents**



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## 1. Introduction

Global climate change is now occurring since long and that its manifestations threaten the stability of societies as well as natural and managed ecosystems. Increases in ambient temperature and changes in related processes are directly linked to rising anthropogenic greenhouse gas (GHG) concentrations in the atmosphere [1]. The potential related impacts of climate change on the ability of agricultural systems, which include soil and water resources, to provide food, feed, fiber, and fuel, and maintenance of ecosystem services (e.g., water supply and habitat for crop landraces, wild relatives, and pollinators) as well as the integrity of the environment, are major concerns.

Climate is defined as long term weather pattern that describe a region. "Climate change" [2,3] refers to a change in the state of the climate that can be identified by changes in the mean and variability of its properties and persists for extended periods decades or longer [4]. Climate change [5,6] could occur naturally as a result of a change in the Sun's energy or as a result of persistent anthropogenic forces such as greenhouse gases, sulfate aerosol or black carbon [7] to the atmosphere or through land use change.

Climate change considerations call for such major policies as the reduction of GHG emissions [8], including lowering carbon intensity of economies with less fossil fuel (such as oil and coal) mined, burned, traded, introducing cleaner technologies, climate change mitigation and adaptation. Global climate change poses serious threats to the region's environment, ecological and socio-economic systems. Agricultural production has already decreased in some commodity groups and quantities and qualities of water resources are at risk of severe effects of climate change.

Shifting weather patterns, for example, threaten food production [9] through increased unpredictability of precipitation, rising sea levels contaminate coastal freshwater reserves and increase the risk of catastrophic flooding, and a warming atmosphere aids the pole-ward spread of pests and diseases once limited to the tropics.

## 2. Causes of climate change

Climate change is a major threat in world. There are several reasons for global climate change. Among them green house gas emission is the major cause for climate change. Unsustainable consumption patterns of the rich industrialized nations are responsible. Rapid transportation of goods causes the emissions of carbon dioxide, nitrogen dioxide, sulfur dioxide, non methane hydrocarbon. These harmful gases are the cause for climate change. Also energy consumption, land use, noise, water and soil pollution may be the cause of climate change.

### 2.1. Greenhouse effect and greenhouse gases

The greenhouse effect [10] is a warming process that balances Earth's cooling processes. During this process, sunlight passes through Earth's atmosphere as short-wave radiation. Some of the

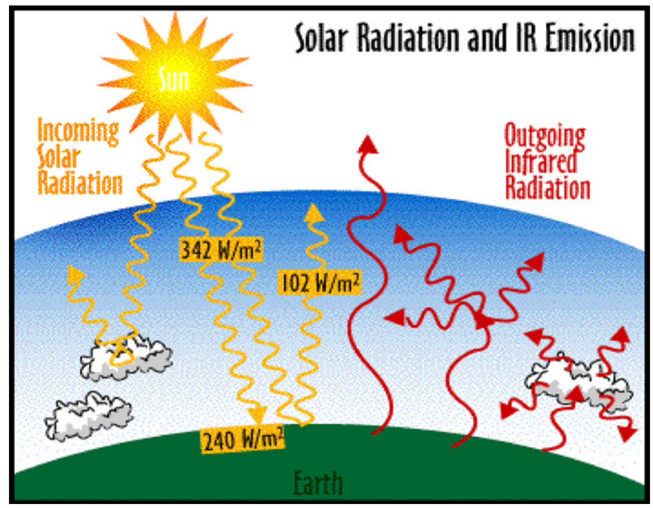



**Fig. 1.** Solar radiation [10].

radiation is absorbed by the planet's surface. As Earth's surface is heated, it emits long wave radiation toward the atmosphere. In the atmosphere, some of the long wave radiation is absorbed by certain gases called greenhouse gases [11]. Greenhouse gases include carbon dioxide ($CO_2$), chlorofluorocarbons (CFC's), methane ($CH_4$), nitrous oxide ($N_2$), troposphere ozone ($O_3$) [12], and water vapor. Each molecule of greenhouse gas becomes energized by the long wave radiation. Fig. 1 shows the green house effect due to solar radiation and infrared emission.

The energized molecules of gas then emit heat energy in all directions. By emitting heat energy toward Earth, greenhouse gases increase Earth's temperature. The greenhouse effect [13] is a necessary phenomenon that keeps all Earth's heat from escaping to the outer atmosphere. Without the greenhouse effect, temperatures on Earth would be much lower than they are now and the existence of life on this planet would not be possible. However, too many greenhouse gases in Earth's atmosphere could increase the greenhouse effect.

### 2.2. Sulfate aerosol and black carbon

Sulfate aerosols and black carbon [5] are two important additional examples of anthropogenic forcing. Sulfate aerosols, which enter the atmosphere naturally during volcanic eruptions, are tiny airborne particles that reflect sunlight back to space. Industrial activity has recently increased their concentration in the atmosphere primarily through the burning of fossil fuels containing sulfur. Anthropogenic emissions of sulfate aerosols have been associated with a net cooling effect.

Black carbon [14,15] is soot generated from industrial pollution, traffic, outdoor fires, and the burning of coal and biomass fuels. Black carbon [16] is formed by incomplete combustion especially

of coal, diesel fuels, biofuels and outdoor biomass burning. Soot particles absorb sunlight, both heating the air and reducing the amount of sunlight reaching the ground.

### 2.3. Land-use change

The combustion of fossil fuels is not the only anthropogenic source of carbon dioxide [17]. When ecosystems are altered and vegetation is either burned or removed, the carbon stored in them is released to the atmosphere as carbon dioxide. The principal reasons for deforestation are agriculture and urban growth as well as harvesting timber for fuel, construction, and paper. Currently, up to a quarter of the carbon dioxide emissions to the atmosphere can be attributed to land-use [48] change.

### 2.4. Emissions from freight transport

The climatic impacts of emissions from freight transport [18] are more than the direct impacts from carbon dioxide. In case of air transport it includes the direct effects of water vapor, the indirect forcing on climate resulting from changes in the distributions and concentrations of ozone and methane as a consequence of aircraft nitrogen oxide emissions, the direct effects from emitted aerosols and the climate effects associated with cirrus cloud formation.

## 3. Impacts of climate change

In the energy sector, climate change will have a direct effect on both the supply and demand of energy. The projected impact of climate changing on precipitation and glacier melt indicates that hydropower production could increase by 5% and decrease by 25%. Climate changing will also have profound effects on human health and on animal and planet health. Weather-related deaths and diseases could rise. The effects of climate change are majorly depends on temperature rising, due to that icecaps and glaciers are melting; extreme weather events are becoming more frequent and more intense. Global climate change has physical, socio economic impacts [5] of which major impacts are mentioned below.

The impacts on human cycle and systems of the climate change will probably be distributed unevenly. Some regions and sectors are expected to experience benefits from these while others will experience the costs of these changes. With greater levels of warming (more than 2–3 °C, relative to 1990 levels), it is likely that benefits will decline for the benefactors and costs increase for the sufferers. Low-latitude and under developed areas [19] are probably at a higher risk from the climate change. With human system cycle, adaptation potential for climate change impacts is considerably expensive, although the costs of adaptation are largely unknown and potentially large. Climate change results in decreased diversity of ecosystems, adding many more species to the rare category each year and making many extinct. Adaptation potential for biological and geophysical systems is much lower than that for human systems cycle as a whole.

The major impacts of global climate changes are manifested in gradual rise in global surface temperature (i.e. global warming), melting of ice-bergs and concomitant rise in sea-levels [20], continuous build-up of greenhouse gases [17] leading to ‘green-house effect’, depletion of ozone concentration/layers, catastrophic natural disaster and calamities (e.g., hurricane, typhoons, earthquakes, landslides, Tsunami), loss of vegetation, plant, animal lives, biodiversities, marine flora & fauna, etc. The widespread retreat of glaciers and icecaps in the 21st century will also lead to higher surface temperatures on land and increasing water stress [21]. By 2025, as much as two-thirds of the world population, much of it in the underdeveloped third world, may be subjected to moderate to high water stress.

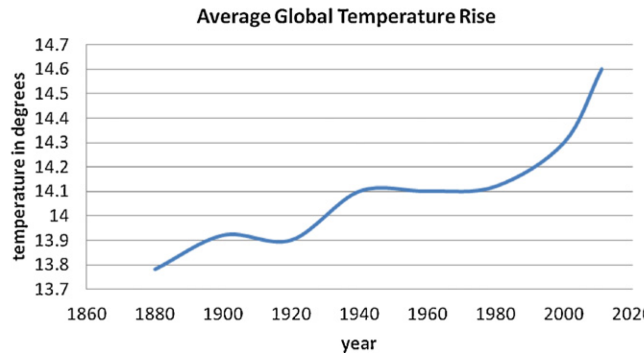



**Fig. 2.** The graph of average global temperature rise.

### 3.1. Temperature rise and global warming

Greenhouse effects increase mean global temperatures as well as changes precipitation patterns. The real threat of climate change lies how rapidly the change occurs. For example, over the past 140 years [22], the mean global temperature appears to have risen to 1.6 °F (0.9 °C). These temperatures changes are depicted in the graph below. The increasing steepness of the curve [22] suggests that changes in mean global temperature have occurred at greater rates over time. Further evidence suggests that future increases in mean global temperature may occur at a rate of 0.4 °F (0.2 °C) each decade. Abrupt rise in atmospheric temperature causes disappearance of snows and glaciers which increases the mean sea level [23] (Fig. 2).

### 3.2. Increased freshwater flow

Research based on satellite observations, published in October, 2010, shows an increase in the flow of freshwater into the world’s oceans, partly from melting ice and partly from increased precipitation driven by an increase in global ocean evaporation [24]. The increase in global freshwater flow, based on data from 1994 to 2006, was about 18%. Much of the increase is in areas which already experience high rainfall. One effect, as perhaps experienced in the 2010 Pakistan floods, is to overwhelm flood control infrastructure.

### 3.3. Marine ecology

Global warming has complex impact on marine ecology. The oceans serve as a sink for carbon dioxide, taking up much that would otherwise remain in the atmosphere, but increased levels of $CO_2$ have led to ocean acidification [12]. Furthermore, as the temperature of the oceans increases, they become less able to absorb excess $CO_2$. The amount of oxygen dissolved in the oceans may decline, with adverse consequences for ocean life [8].

### 3.4. Health impact

Global climate change also leads occurrence of infectious diseases like malaria, dengue, etc. Due to the excessive temperature rise we are getting higher temperature. Higher temperature brings more extreme weather events. Drought, floods, and storms may increase death and injury rates as well as prevalence of psychological disorders and infectious diseases like vector borne disease, diseases from unsanitary water and food [13].

### 3.5. Extreme events

The climate change would increase the extreme natural events such as floods and weather disasters, Heat waves, drought, forest fires, etc. [5]. In developing countries like India, China and other south Asian countries [25] climate change could represent an additional stress on environmental and socioeconomic systems that are already facing tremendous pressures due to rapid urbanization, industrialization and economic development. With its huge and growing population, a over 7500 km long densely populated and low lying coastline, and an economy that is closely tied to its natural resource base, India and China are considerably vulnerable to the impacts of climate change [7] in south Asian countries.

### 3.6. Risk of lower production in agriculture sector

Higher soil temperatures alter nutrient and carbon cycling by modifying the habitat of soil biota, which in turn affects the diversity and structure of species and their abundance.

Heavier downpours in some regions will lead to increased soil erosion [20]. In addition increased precipitation will result in water-logging of soils, thereby limiting oxygen supply to crop roots and increasing emissions of nitrous oxide and methane. Altered rainfall, whether through increased or decreased precipitation, will affect soil chemistry and biology. Prolonged spells of heat and drought between rainy periods may cause wilting, desiccation, and soil salinization, which may in combination reduce crop yields.

In agriculture projected climatic changes [9] will affect crop yields, live stock management and the location of production. The increasing severity of extreme weather patterns will increase the risk of crop failure. The effects of climate change on forests are changes the health of the forest and productivity and changes to the geographic range of certain free species.

### 3.7. Glacier retreat, rise of sea levels and temperature

Various studies going on in the direction, i.e. the impact due to climate change. As per the United Nation climate report [4], the Himalayan glaciers [26] that are the sources of Asia's biggest rivers Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow could disappear by 2035 as temperatures rise. Approximately, 2.4 billion people live in the drain age basin of the Himalayan Rivers. India, China, Pakistan, Bangladesh, Nepal and Myanmar could experience floods followed by droughts in coming decades. In India alone, the Ganges provides [3] water for drinking and farming for more than 500 million people. It has to be recognized, however, that increased seasonal runoff of Himalayan glaciers led to increased agricultural production in northern India throughout the 20th century. The role of the oceans in global warming is a complex one. The oceans serve as a sink for carbon dioxide, taking up much that would otherwise remain in the atmosphere, but increased levels of $CO_2$ have led to ocean acidification. Furthermore, as the temperature of the oceans increases, they become less capable to absorb excess $CO_2$. Global warming is projected to have a number of effects on the oceans. Ongoing effects include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to increased temperature stratification. The temperature of the Antarctic Southern Ocean [24] rose by 0.17 °C (0.31 °F) between the 1950s and the 1980s, nearly twice the rate for the world's oceans as a whole.

## 4. Remedial and mitigation action

Climate change mitigation action is to decrease the potential effects of global warming and also it involves reduction in the concentration of green house gases emissions and wasteland development. Reforestation and avoid deforestation. Based on the opportunity costs of the land use that would no longer be available for agriculture if deforestation were avoided, also we can save the emissions of carbon dioxide. By the afforestation and reforestation we can control the entire temperature of the atmosphere.

### 4.1. Population

Various organizations promote population control as a means for mitigating global warming. The proposed plan including access of family planning and reproductive health care and information, reducing complicated politics, public education about the population growth [3].

### 4.2. Greenhouse gas remediation and carbon sequestration

It has been proposed as a method of reducing the amount of radioactive forcing. Carbon sequestration [14] is a term that describes processes that remove carbon from the atmosphere. The meanings of artificially capturing and storing carbon, as well as of enhancing natural sequestration processes, are being explored.

### 4.3. Bio-energy with carbon capture and storage

During its growth, biomass traps carbon dioxide [16] from the atmosphere through photosynthesis. When the biomass decomposes or is combusted, the carbon is again released as carbon dioxide. This process is part of the global carbon cycle. Through the use of biomass for energy and materials, e.g. in biomass fuelled power plants, parts of this cycle are controlled by man. Combining these biomass systems with carbon capture and storage technologies, so-called bio-energy with carbon capture and storage, BECCS, is achieved. BECCS systems result in net-negative carbon dioxide emissions, i.e. the removal of carbon dioxide from the atmosphere. In comparison with other geo engineering options, BECCS has been suggested as a low-risk, near-term tool to effectively remove carbon from the atmosphere [11].

### 4.4. Carbon capture and storage

Carbon capture and storage (CCS) [27] is a plan to mitigate climate change by capturing carbon dioxide ($CO_2$) from large point sources such as power plants and subsequently storing it away safely instead of releasing it into the atmosphere. The Agency says CCS is "the most important single new technology for $CO_2$ savings" in power generation and industry. It requires up to 40% more energy to run a CCS coal power plant than a regular coal plant [12].

### 4.5. Eliminating waste methane

Methane [28] is a significantly more powerful greenhouse gas than carbon dioxide. Burning one molecule of methane generates one molecule of carbon dioxide. Accordingly, burning methane which would otherwise be released into the atmosphere (such as at oil wells, landfills, coal mines, waste treatment plants, etc.) provides a net greenhouse gas emissions [29] benefit. However, reducing the amount of waste methane produced in the first place has an even greater beneficial impact, as might other approaches to productive use of otherwise-wasted methane [30].

### 4.6. Energy efficiency and conservation

Efficient energy use, sometimes simply called "energy efficiency", is the goal of efforts to reduce the amount of energy



**Fig. 3.** Fluorescent lamp [12].

required to provide products and services. For example, insulating a home allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Installing fluorescent lights or natural skylights reduces the amount of energy required to attain the same level of illumination compared to using traditional incandescent light bulbs [12] (Fig. 3).

Compact fluorescent lights use two-thirds less energy and may last 6–10 times longer than incandescent lights. Energy is broader than energy efficiency in that it encompasses using less energy to achieve a lesser energy service, Examples of conservation without efficiency improvements would be heating a room less in winter, driving less, or working in a less brightly lit room. Reducing energy use is seen as a key solution to the problem of reducing greenhouse gas emissions [16]. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions [31] of greenhouse gases.

### *4.7. Transport*

Modern energy efficient technologies, such as plug-in hybrid electric vehicles, and development of new technologies, such as hydrogen cars, may reduce the consumption of petroleum and emissions of carbon dioxide. A shift from air transport and truck transport to electric rail transport would reduce emissions significantly [11].

Increased use of bio-fuels (such as ethanol fuel and biodiesel that can be used in today's diesel and gasoline engines) could also reduce emissions [32] if produced environmentally efficiently, especially in conjunction with regular hybrids and plug-in hybrids. For electric vehicles, the reduction of carbon emissions [33] will improve further if the way the required electricity is generated is low-carbon (from renewable energy sources).

Effective urban planning to reduce sprawl would decrease vehicle miles travelled (VMT), lowering emissions from transportation. Increased use of public transport can also reduce greenhouse gas emissions per passenger kilometer.

### *4.8. Increasing the use of renewable sources of energy*

Renewable energy sources play a role in providing energy services in a sustainable manner and, in particular, in mitigating climate change. This Special Report on Renewable Energy Sources and Climate Change Mitigation explores the current contribution and potential of renewable energy (RE) sources to provide energy services for a sustainable social and economic development path. It includes assessments of available RE resources and technologies, costs and co-benefits, barriers to up-scaling and integration requirements, future scenarios and policy options. Various renewable energy sources namely wind, solar, tidal and wave energy can be used to prevent carbon emissions in the atmosphere [8]. Wind farm, micro-hydroelectric plants, biomass and cogeneration power plants, biomass based gassifiers systems and solar photovoltaic systems [49] must be implemented for saving the climate [34].

The IPCC Fourth Assessment Report (AR4) reported [19,35] that fossil fuels provided 85% of the total primary energy in 2004 [36], which is the same value as in 2008 [23]. Furthermore, the combustion of fossil fuels accounted for 56.6% of all anthropogenic GHG emissions ($CO_2$) in 2004 [37]. To maintain both a sustainable economy that is capable of providing essential goods and services to the citizens of both developed and developing countries, and to maintain a supportive global climate system, requires a major shift in how energy is produced and utilized [38]. However, renewable energy technologies, which release much lower amounts of $CO_2$ than fossil fuels are growing.

Renewable energy sources play an important role in providing energy [32] services and security in a sustainable manner and, in particular, in mitigating climate change. This paper gives importance on Renewable Energy Sources and Climate Change Mitigation, exploring the current contribution and potential of renewable energy (RE) sources to provide energy services and security for a sustainable social [51] and economic development path (Fig. 4).

## 5. Climate changing and mitigation action in developing countries

Climate change and its impact on our environment, our economies and our security, is the defining issue of our era. But every day of inaction makes its consequences more irreversible, so we need to act now. Identification and selection of actions to mitigate GHG emissions [47] will be a great challenge because these emissions are strongly tied to living activities that support human life systems. However, these activities cover a wide range, from ones crucial to human well-being to those leading to affluence and over-consumption. This broad activity range provides opportunity to search for possible replacement of high emission intensive activities with less emission intensive ones and even provide room for innovation.

Developing countries actions [39] to solve the climate problem will be difficult because the likely impact of the problem is global and no one country or group of countries can provide its own remedy. The cooperation of countries and coordination of national efforts will be central in any solution to this problem. It is therefore necessary that countries world-wide cooperate through regional and international mechanisms such as the Framework Convention on Climate Change (FCCC) which recently came into force to tackle the global climate problem [40].

GHG emissions associated with the provision of energy services are a major cause of climate change. The IPCC Fourth Assessment Report ($AR_4$) concluded [35,41] that "Most of the observed increase in global average temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations." Concentrations of $CO_2$ have continued to grow and by the end of 2010 had reached 390 ppm $CO_2$ or 39% above pre-industrial levels.

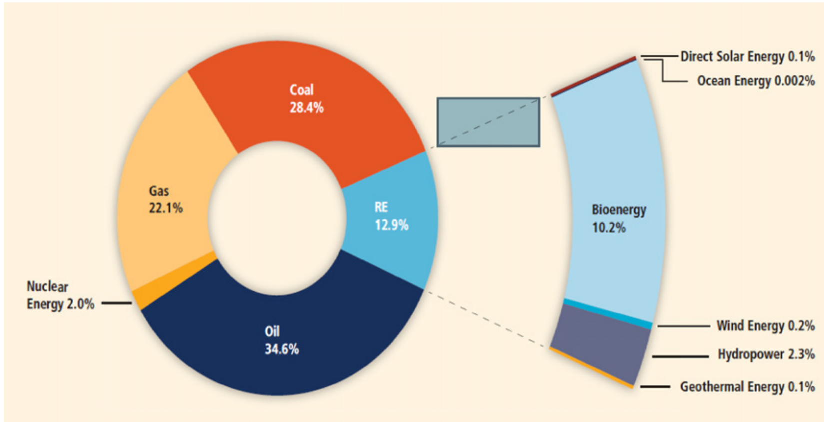



**Fig. 4.** Distribution of energy sources in total global primary energy supply in 2008 (492 EJ). Modern biomass contributes 38% to the total biomass share. *Data source*: IEA [23].

### *5.1. Climate change and envisaged impact on India and the South Asian countries*

India and China are the two fastest developing countries in south Asia, which are also the two most populated ones, almost half of the world population lives in these countries the impact on the climate due to the rapid development in these countries is severe. The infrastructure and Industrial growth to meet the consumption of these densely populated countries is taking the toll on environment. The forests are vanishing to give space to meet the needs for these developments. The industrial and automobile pollution [42,43] is depleting the ozone layer leading to global warming; the increasing temperatures are making the glaciers melt and lead to natural calamities like floods taking many human lives now and then. The coastlines are receding due to the rising seas reducing the land area, the marshy lands and mangroves are destroyed by way of reclamation for making the space available for buildings, houses and industries. The rate of growth of development in India and China is having a higher impact on overall climate change then developments in rest of the world.

According to a UN climate report [4], the Himalayan glaciers that are the sources of Asia's biggest rivers Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow could disappear by 2035 as temperatures rise. Approximately, 2.4 billion people live in the drainage basin of the Himalayan Rivers. India, China, Pakistan, Bangladesh, Nepal and Myanmar could experience floods followed by droughts in coming decades. In India alone, the Ganges provides water for drinking and farming for more than 500 million people. It has to be acknowledged, however, that increased seasonal runoff of Himalayan glaciers led to increased agricultural production in northern India throughout the 20th century. The role of the oceans in global warming is a complex one. The oceans serve as a sink for carbon dioxide, taking up much that would otherwise remain in the atmosphere, but increased levels of $CO_2$ have led to ocean acidification. Furthermore, as the temperature of the oceans increases, they become less capable to absorb excess $CO_2$. Global warming is projected to have a number of effects on the oceans. Ongoing effects include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to increased temperature stratification.

The various studies conducted in the country have shown that the surface air temperatures in India are going up at the rate of $0.4\,^{\circ}C$ per hundred years, particularly during the post-monsoon and winter season [9]. India is heavily dependent on the monsoon to meet its agricultural and water needs, and also for protecting and propagating its rich biodiversity.

Increase in temperatures will result in shifts of lower altitude tropical and subtropical forests to higher altitude temperate forest regions, resulting in the extinction of some temperate vegetation types. Increased dry spells could also place dry and moist deciduous forests at increased risk from forest fires. Climate change will make monsoons unpredictable. As a result, rain-fed wheat cultivation in South Asia will suffer in a big way.

### *5.2. Mitigation action taken by developing countries*

As mentioned previously, the threat of climate instability will have global impacts and no single country can solve it. However, its solution lies on the coordination of national actions within regional and international frameworks. The solution will need to involve countries world-wide because the impact of GHG emitted in one location may be felt in a completely different location. Hence, countries should develop a plan of action to cope with this problem. Such plan should be long-term [50] in nature, be capable to respond to uncertainties and un-planned events, and can be adjusted to suit new information as they become known.

Despite the plan will be primarily based on national actions, but international concerns will be important because as trade between countries get more intensified, actions by one country will affect the other. Further, actions to reduce GHG emissions will have serious economic implications due to its link with human activities, so involve restructuring of economic sectors. In addition, the growing inters relationships among countries especially in world trade means that certain national actions will have economic and financial impacts globally. Such price change of certain commodities may affect the competitive position of a country in global markets. Therefore, developing countries needs plans and require adequate action.

#### *5.2.1. Investigating carbon or energy pricing*

Many developed and developing countries have introduced, or are seriously considering introducing, market based measures to help meet their emissions reduction targets. Emissions trading schemes already operate in 31 European countries [44] and New Zealand, and in 10 US states. They are under active consideration in other countries, including China, South Korea and in several Canadian provinces. Carbon taxation is in place in the United Kingdom, Denmark, Finland, Norway, Sweden, the Netherlands and Canada and under discussion or proposed elsewhere, including in the EU, Japan and South Africa.

India has implemented a coal tax to fund research and development on renewable energy technologies [45]; and South Africa

released in December 2010 a carbon tax discussion paper [46] for public comment. In June 2010, China [30] introduced a value-based tax on coal, oil and gas extraction in China's largest gas-producing province (Xinjiang Uighur Autonomous Region) and plans to extend it to all other western provinces.

*5.2.2. Implementation of GHG friendly policies*

GHG emissions associated with the provision of energy services are a major cause of climate change. The IPCC Fourth Assessment Report ($AR_4$) [19] concluded that "Most of the observed increase in global average temperature since the mid 20th century [26,42] is very likely due to the observed increase in anthropogenic greenhouse gas concentrations." Concentrations of $CO_2$ have continued to grow and by the end of 2010 had reached 390 ppm $CO_2$ or 39% above pre-industrial levels.

India has for quite some time pursued GHG friendly policies in her own interest. India's obligation to minimize energy consumption particularly oil consumption and to deal with its environmental problems prompt it to follow many such policies. Directly or indirectly these efforts are made by Government [3] as well as by people to reduce energy consumption. These include:

(a) Importance on renewable energy conservation.
(b) Promotion of renewable energy sources.
(c) Abatement of air pollution.
(d) A forestation and wasteland development.
(e) Economic reforms, subsidy removal and joint ventures in capital goods.
(f) Fuel substitution policies.

All of the above save energy at the cost of human welfare. Clearly, it is not recommended to continue the existing state of affairs If India is committed to human development; poverty eradication should take place with control on carbon emissions. The poverty eradication may result in an increased energy use. This may be considered a due right of the poor, though it increases India's GHG emissions. Thus people of India should rise and take the above mentioned initiatives in their day to day stride to ensure that the carbon emission is reduced and GHG friendly policies are respected and enforced religiously.

*5.2.3. Implementation of renewable energy sources*

Renewable energy sources play a role in providing energy services and security in a sustainable manner and, in particular, in mitigating climate change. Various researches going on in the field of Renewable Energy Sources and Climate Change Mitigation explores the current contribution and potential of renewable energy (RE) sources to provide energy services for a sustainable social and economic development path. These research works gives the information about the availability of RE resources and technologies, costs and co-benefits, barriers to up-scaling and integration requirements, future scenarios and policy options. While the RE share of global energy consumption is still relatively small, deployment of RE has been increasing rapidly in recent years. Of the approximately 300 GW of new electricity generating capacity added globally over the two-year period from 2008 to 2009, 140 GW came from RE additions. Collectively, developing countries hosted 53% of global RE power generation [46] capacity in 2009. Under most conditions, increasing the share of RE in the energy mix will require policies to stimulate changes in the energy system.

## 6. Conclusion

The rapid use of human hydrocarbon or increasing atmospheric carbon dioxide and other green house gases are causing unfavorable changes in global temperatures, weather patterns and landscape. This can be mitigated majorly by various types of renewable energy sources. To avoid the worst predicted impacts of climate change, institutions and individuals must act now. So-many remedial, we have discussed here to avoid climate change have to be implemented strategically. We have to use more electric vehicles and bio-fuels vehicles to prevent the emissions of carbon in atmosphere. We have to use more fluorescent lamp instead of traditional incandescent light bulbs to save the energy. We have to be careful of plantation to remove more carbon dioxide from the atmosphere. We have to adapt proper planning to save our climate from changing.

Compared with burning coal or gas in conventional power generating plant designs, there are several alternative technological ways to generate electricity and reduce green house gas emissions cost effectively. Renewable energy sources and carbon dioxide sequestration, these new concept gives future opportunity for costs to be reduced with further experience. Each and every goods transport must be more environmentally friendly and reduces logistics costs as it focuses on reducing energy consumption and on improving the overall supply chain.

## References

[1] Brown S. Opportunities for mitigating carbon emissions through forestry activities. Arlington, VA: Winrock International; 1999. March.
[2] Jyoti P, Gokarn S. Climate change and India's energy policy options. Global Environmental Change 1992;3(3):276–91.
[3] National Action Plan on Climate Change, Prime Minister's Council on Climate Change, Government of India; 30 June 2008, available at http://pmindia.nic.in/Pg 01-52.
[4] United Nations Intergovernmental Panel on Climate Change (IPCC).Third Assessment Report. Working Group 3. England: Cambridge University Press; 2001 (Chapter 3).
[5] National Academy of Sciences (NAS). Climate change science: an analysis of some key questions. National Academies; 2001. p. 44.
[6] Parikh JK, Parikh K. Climate change: India's perceptions, positions, policies and possibilities. OECD; 2002.
[7] Mitra AP. Global change greenhouse gas emission in India-methane budget estimates from rice fields based on data available up to 1995. Scientific report no. 10. New Delhi, India: Publication and Information Directorate, CSIR; July 1996.
[8] Nema P, Nema RK, Rangnekar S. Minimization of green house gases emission by using hybrid energy system for telephony base station site application. Renewable and Sustainable Energy Reviews 2010;14:1635–9.
[9] Kumar K, Kavi S, Parikh J. Indian agriculture and climate sensitivity. Global Environmental Change 2001;11:147–54.
[10] Clancy JS, Malik FU, Shakya I, Kelkar G. Appropriate gender-analysis tools for unpacking the gender–energy–poverty nexus. Gender & Development 2007;15(2):241–57.
[11] Firestone R, Marnay C. Distributed energy resources for carbon emissions mitigation; 2007. June.
[12] Narayan C. Review of $CO_2$ emissions mitigation through prescribed burning. EFI Technical Report 25; 2007.
[13] Intergovernmental Panel on Climate Change (IPCC).Working Group I Third Assessment Report. UK: Cambridge University Press; 2001, 881 pp.
[14] Sims REH, Rogner H-H, Gregory K. Carbon emission and mitigation cost comparisons between fossil fuel nuclear d renewable energy resources for electricity generation. Energy Policy 2003;31:1315–26.
[15] Robinson AB, Robinson NE, Soon W. Environmental effects of increased atmospheric carbon dioxide. Journal of American Physicians and Surgeons 2007;12:79–90.
[16] Firestone R, Marnay C. Distributed energy resources for carbon emissions mitigation. ECEEE 2007;(June).
[17] IPCC. 2006 IPCC guidelines for national greenhouse gas inventories. Hayama, Kanagawa, Japan: Institute for Global Environmental Strategies (IGES) for the IPCC; 2006.
[18] van Agtmaal E.Green logistics consultants group ways of evaluating and mitigating $CO_2$ emissions in goods transport at firm level. 2008.
[19] IPCC. In: Pachauri RK, Reisinger A, editors. Climate change 2007: synthesis report. Contribution of Working Groups I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change, Core Writing Team. Cambridge University Press; 2007. p. 104.
[20] Church JA, Woodworth PL, Aarup T, Wilson WS. Understanding sea-level rise and variability. London: Wiley-Blackwell; 2010, 428 pp.
[21] IPCC. In: Watson RT, Noble IR, Bolin B, Ravindranath NH, Verardo DJ, Dokken DJ, editors. Land use, land use change and forestry. Cambridge University Press; 2000. p. 375.
[22] IEA. Statistics and balances. Paris, France: International Energy Agency; 2009.

[23] IEA. Energy balances of non-OECD countries. Paris, France: International Energy Agency; 2010.
[24] Venema H, Rehman I. Decentralized renewable energy and the climate change mitigation–adaptation nexus. Mitigation and Adaptation Strategies for Global Change 2007;12:875–900.
[25] Padukone N. Climate change in India: forgotten threats, forgotten opportunities. EPW 2010;XLV(May (22)).
[26] Sarkar AN. Global climate change and emerging environmental and strategic security issues for South Asia'. Journal of Environmental Protection 2011;2:1162–71.
[27] IPCC. In: Metz B, Davidson O, de Coninck H, Loos M, Meyer L, editors. Special report on carbon dioxide capture and storage. Cambridge University Press; 2005. p. 431.
[28] IEA. $CO_2$ emissions from fuel combustion highlights 2010. Paris, France: International Energy Agency; 2010.
[29] Jacobson M. Review of solutions to global warming, air pollution and energy security. Energy and Environmental Science 2009;2:148–73.
[30] Van Ruijven B, van Vuuren D. Oil and natural gas prices and greenhouse gas emission mitigation. Energy Policy 2009;37(11):4797–808.
[31] IPCC. In: Nakicenovic N, Swart R, editors. Special report on emission scenarios. Cambridge University Press; 2000, 570 pp.
[32] Verbruggen A, Fischedick M, Moomaw W, Weir T, Nadai A, Nilsson LJ, Nyboer J, Sathaye J. Renewable energy costs, potentials, barriers: conceptual issues. Energy Policy 2010;38(2):850–61.
[33] World Bank. World development indicators – $CO_2$ emissions (kt). Washington, DC, USA: World Bank; 2009. Available at: data.worldbank.org/indicator/EN.ATM. CO2E.KT/countries/1W?display=graph.
[34] Clarke L, Kyle P, Wise M, Calvin K, Edmonds J, Kim S, Placet M, Smith S. $CO_2$ emissions mitigation and technological advance: an analysis of advanced technology scenarios; 2008. December.
[35] Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA, editors. Contribution of Working Group III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom/New York, NY, USA: Cambridge University Press; 2007.
[36] Sims REH, Schock RN, Adegbululgbe A, Fenhann J, Konstantinaviciute I, Moomaw W, Nimir HB, Schlamadinger B, Torres-Martinez J, Turner C, Uchiyama Y, Vuori SJV, Wamukonya N, Zhang X. Energy supply. In: Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA, editors. Climate change 2007: mitigation of climate change. Contribution of Working Group III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2007. p. 251–322.
[37] Rogner H-H, Zhou D, Bradley R, Crabbe P, Edenhofer O, Hare (Australia) B, Kuijpers L, Yamaguchi M. Introduction. In: Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA, editors. Climate change 2007: mitigation of climate change. Contribution of Working Group III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2007. p. 95–116.
[38] Kankam S, Boon E. Energy delivery and utilization for rural development: lessons from Northern Ghana. Energy for Sustainable Development 2009;13(3):212–8.
[39] IEA. World energy outlook 2010. Paris, France: International Energy Agency; 2010, 736 pp.
[40] IEA. World energy outlook 2009. Paris, France: International Energy Agency; 2009, 696 pp.
[41] Intergovernmental Panel on Climate Change (IPCC). Climate change; 2007.
[42] Greenhouse Effect, http://en.wikipedia.org/wiki/Greenhouse.
[43] Climate Change and its Impact of India, http://www.greenpeace.org/india/Campaigns/choose-positive-energy/what-is-climate-change.
[44] IEA. Midterm oil and gas markets 2010. Paris, France: International Energy Agency; 2010.
[45] Government of India, Ministry of Finance, Notification No. 01/2010-Clean Energy Cess; 22 June 2010, http://www.coal.nic.in/cbec140710.pdf.
[46] Chaurey A, Kandpal T. Assessment and evaluation of PV based decentralized rural electrify cation: an overview. Renewable and Sustainable Energy Reviews 2010;14(8):2266–78.
[47] Ba-Shammakh M, Caruso H, Elkamel A, Croiset E, Douglas PL. Analysis and optimization of carbon dioxide emission mitigation options in the cement industry. American Journal of Environmental Sciences 2008;4(5):482–90.
[48] Fisher B, Nakicenovic N, Alfsen K, Corfee Morlot J, de la Chesnaye F, Hourcade J-Ch, Jiang K, Kainuma M, La Rovere E, Matysek A, Rana A, Riahi K, Richels R, Rose S, van Vuuren D, Warren R. Issues related to mitigation in the long term context. In: Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA, editors. Climate change 2007: mitigation of climate change. Contribution of Working Group III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2007. p. 169–250.
[49] IEA. Key world energy statistics 2010. Paris, France: International Energy Agency; 2010.
[50] IEA. World energy outlook 2010. Energy poverty: how to make modern energy access universal. Paris, France: International Energy Agency; 2010.
[51] Hofman Y, de Jager D, Molenbroek E, Schilig F, Voogt M. The potential of solar electricity to reduce $CO_2$ emissions. Utrecht, The Netherlands: Ecofys; 2002, 106 pp.